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TIMOTHY BENNETT / 1034A

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This document consists of 6 pages
No. 3 of 6 copies, Series A.

TO Mr. J. A. Marshall
LOCATION K-303-7

DATE February 11, 1953

ANSWERING LETTER DATE

ATTENTION

COPY TO Messrs. J. A. Parsons (K-25RC)
M. F. Schwenn ✓
R. D. Shaffer
B. H. Thompson
A. Varlan

SUBJECT Feed Plant Roughing Traps

KP 444 3 A

KP-444

KP 444 3 A

Condensation facilities are provided in Building K-1131 to remove product uranium hexafluoride from the effluent gases of the fluorination towers. Since normal production rates resulted in rapid plugging of the primary cold traps, roughing traps cooled by sanitary water were placed between the primary traps and the towers to reduce the uranium hexafluoride concentration in the gas to a maximum of ten mol per cent. The sanitary water temperature in the winter, approximately 52°F., is low enough to effect the desired condensation; however, if the present operating pressure of approximately 17 psia. is maintained, the higher water temperature anticipated in the summer, on the order of 80°F., will result in effluent gas from the roughing traps which contains considerably more than the desired concentration of uranium hexafluoride. As a result, an investigation is in progress to determine the most practicable revision which will assure removal of at least 90 per cent of the uranium hexafluoride from the gas stream. One means to alleviate this problem involves providing a refrigeration system which will supply coolant to the roughing traps at temperatures necessary for satisfactory operation at the present pressure; a recirculating coolant system would be advisable under these conditions. An alternate solution is to install a new gas compression system which will maintain higher pressures in the roughing traps, thus permitting satisfactory operation with sanitary water at the anticipated higher temperatures. Various possible compression units were investigated and it was determined that either the Valley Iron Works pump or the two-stage Elliott centrifugal blower could be adapted to yield the desired performance. It was also determined that refrigeration capacity available in Building K-1131 is sufficient to permit refrigeration of recirculating coolant for the traps. A comparison of costs between the two alternatives indicates that it will be more economical to install the recirculating coolant system, consisting of a coolant pump, a heat exchanger tied into the plant carbon dioxide refrigeration facilities, and the necessary piping and operational controls.

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Three pumps were included in this study: the Valley Iron Works reciprocating pump, the Elliott two-stage centrifugal blower, and the five-stage centrifugal blower, which was designed, constructed, and utilized for this function before the roughing traps were installed. Characteristics of these compression units in single stage operation and in specified two-stage combinations were studied to determine the discharge temperature, the speed, and the horsepower requirements for each unit operating with 25 and 35 per cent uranium hexafluoride in nitrogen, at discharge pressures of 20 psia. and 25 psia. for the single stage system, and 25 psia. for the two stage system. The results of these computations are presented in tables one and two.

The performance curves of the Elliott blower were extrapolated from operational tests obtained at a gas concentration of 90 per cent uranium hexafluoride; whereas, a limited amount of test data for the five-stage centrifugal pump were available (1) for conditions approximating those assumed in these calculations. On the other hand, the characteristics of the Valley Iron Works pump were calculated strictly on the basis of the physical construction of the pump. Actual light contaminants in the gas stream consist of varying concentrations of air, nitrogen, oxygen, fluorine, and hydrogen fluoride. Since the molecular weight of nitrogen is close to that of the other diluents, computations of the average molecular weights of the pumped gas were simplified by assuming that the gas stream is composed of uranium hexafluoride and nitrogen.

Investigation of the physical strengths of the load bearing, the thrust bearing, the shaft, and the impeller key indicates that these components are adequate for the higher loads imposed by the increased pressures in the five-stage blower when this unit is operated as the second stage in a dual-unit compression system. Use of the Valley Iron Works pump under the assumed conditions would necessitate installation of valve keepers, since the unsupported feather valves probably would fail when subjected to the pressure differentials resulting from this application.

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(1) Ziemke, M. C., and Carey, W. T., Multi-Stage Gas Blowers, Carbide and Carbon Chemicals Company, K-25 Plant, March 12, 1952 (K-873).

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TABLE I

Summary of Pump Characteristics

25% UF_6 - 75% N_2

	Suction Volume, cfm.	Suction Temperature, °F.	Suction Pressure, psia.	CR	Theoretical[1] ΔT, °F.	Theoretical[1] Adiabatic Horsepower	Speed, rpm.	Discharge Pressure, psia.
Single Stage								
V. I. W.	150	250	10.0	2.00	76	4.77	344[2]	20
	150	250	10.0	2.50	102	6.42	344[2]	25
Elliott[3]	250	250	9.5	2.10	82	8.10	14,500	20
	250	250	9.5	2.63	109	10.80	16,000	25
Two-Stage								
5-stage blower and	150	250	9.5	1.50	44[4]	2.60	3,600	14.3
5-stage blower	100	340[4]	14.3	1.40	40	2.30	3,600	20(maximum)
Elliott pump[3] and	250	250	9.5	1.88	68[4]	6.86	14,000	17.9
5-stage blower	86	325[4]	17.9	1.40	40	2.33	3,600	25
5-stage blower and	150	250	9.5	1.50	44[4]	2.61	3,600	14.3
Elliott pump[3]	200	340[4]	14.3	1.75	63	7.29	13,500	25

(1) ΔT and hp. are calculated theoretical values, and, therefore, must be corrected in accordance with the anticipated efficiency.

(2) This speed for pump as double-acting unit; for single-acting, double the speed.

(3) Recycle line with aftercooler necessary to supply sufficient suction volume.

(4) ΔT efficiency for Elliott estimated at 80% and for 5-stage blower at 50% in order to estimate second stage suction temperature.

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TABLE II

Summary of Pump Characteristics

35% UF_6 - 65% N_2

	Suction Volume, cfm.	Suction Temperature, °F.	Suction Pressure, psia.	CR	Theoretical(1) ΔT, °F.	Theoretical(1) Adiabatic Horsepower	Speed, rpm.	Discharge Pressure, psia.
Single Stage								
V. I. W.	150	250	10.0	2.00	62	4.71	344(2)	20
	150	250	10.0	2.50	84	6.32	344(2)	25
Elliott(3)	250	250	9.5	2.10	69	8.07	14,500	20
	250	250	9.5	2.63	90	10.70	15,500	25
Two-Stage								
5-stage blower	150	250	9.4	1.70	47(4)	3.37	3,600	16
and 5-stage blower	90	340(4)	16.0	1.75	56	3.63	3,600	28
Elliott pump(3)	200	250	9.5	1.55	40(4)	3.74	12,000	14.7
and 5-stage blower	97	300(4)	14.7	1.70	50	3.42	3,600	25
5-stage blower	150	250	9.5	1.70	48(4)	3.42	3,600	16.2
and Elliott pump(3)	200	340(4)	16.2	1.55	44	6.39	12,000	25

(1) ΔT and hp. are calculated theoretical values, and, therefore, must be corrected in accordance with the anticipated efficiency.

(2) This speed for pump as double-acting unit; for single-acting, double the speed.

(3) Recycle line with aftercooler necessary to supply sufficient suction volume.

(4) ΔT efficiency for Elliott estimated at 80% and for 5-stage blower at 50% in order to estimate second stage suction temperature.

In view of the above, it is felt that either the Valley Iron Works pump or the Elliott compressor could be modified adequately to operate as a single stage system to provide a discharge pressure of 25 psia.; also, maintenance costs on either unit should be less than those for the present pump. However, installation of the Valley Iron pump is complicated by the size and weight of the unit, and utilization of the Elliott centrifugal blower would require a recycle line equipped with a gas cooler.

In the case of a two component system, the Elliott pump and the five-stage blower can be operated in series to provide the desired pressure. This would permit operation of the Elliott at a slower speed, but a recycle line with a gas cooler would be required for this machine. Although either pump could be operated as the first stage, the structural strength of the internal components of the five-stage blower indicates that this pump would perform more satisfactorily at the lower pressures encountered in the first stage due to the decreased differential pressures experienced across each stage of the impeller. Use of a two-unit pumping system will probably increase the associated maintenance costs and down time.

A preliminary estimate of the expenditures which would be incurred by the various installations is presented in the table below. The costs do not include installation of a spare pumping system, which certainly would be desirable to insure continuous operation.

Installation	Transferred Material	Material	Labor	Plant Expense	Total
Valley Iron Works Pump	$11,150	$1,500	$1,850	$1,850	$16,350
Elliott Blower	5,150	3,300	3,350	3,350	15,100
Refrigerated Coolant	1,000	1,400	1,200	1,200	4,800

The above data indicate the economic desirability of installing a recirculating coolant system and retaining the present gas compression system. Installation of any two-pump compression system utilizing the Elliott pump and the five-stage blower appears to be undesirable on the basis of the initial installation costs and the anticipated increased maintenance costs and down time. Installation of a five-stage centrifugal blower, in addition to the present normal and spare pumps, and provisions for series operation of any two of the three are undesirable because the maximum pressure, 20 psia., obtainable from such a system may be inadequate for the condensation requirements.

Data are not available currently to determine the operating characteristics of the roughing traps at a coolant inlet temperature of 80°F. Present operations, however, show that the traps perform satisfactorily at a coolant inlet temperature of approximately 52°F., and, with the refrigerated coolant system, much more flexibility of operation would be possible. It is recommended, therefore, that a recirculating coolant system be installed, with the heat removed by the existing carbon dioxide refrigeration facilities in Building K-1131. It is further recommended that the stocks of C-716 production by-products in Vault 6A, which are available at no charge, be investigated to determine their applicability for this purpose.

J. A. Parsons

EFMartin:br

ChemRisk/Shonka Research Associates, Inc., Document Request Form

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TIMOTHY BENNETT / 1034A
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K-413 COLD TRAP TEST

T. E. Koprowski

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TO Mr. R. Korsmeyer

LOCATION K-1401

ATTENTION

COPY TO Attached Distribution

DATE January 12, 1951

ANSWERING LETTER DATE

SUBJECT K-413 Cold Trap Test

KP-172

INTRODUCTION

Three cold trap tests were made to obtain necessary data for the design of the cold trap system for Phase II of the UF_6 Feed Plant. The tests were run by using the size 1 cold trap in K-413.

TEST OBJECTIVES

1. Determine the UF_6 holding capacity of a size 1 cold trap, operating at -55°F, by feeding a gas mixture of approximately 73% UF_6 and 27% N_2 at a rate of 333 pounds of UF_6 per hour. The test run was completed when the pressure differential across the trap became 1 psi.

2. A second test was run similar to the test outlined in objective No. 1, with an inlet gas mixture of approximately 40% UF_6 and 60% N_2.

3. Determine the concentration of UF_6 in the cold trap inlet and outlet gas streams during both test runs.

DISCUSSION

The tests were run by making the necessary alterations to the size 1 cold trap which was used for determining design data for Phase I of the Feed Plant.

Four K-631 surge drums, with a volume capacity of 10,685 cubic feet, were isolated and used to make up the mixture of waste UF_6 and nitrogen for the test runs. The UF_6 mixture was valved into K-413 through the K-27 P.W. line and the K-402-2 Beach-Russ booster pumps were utilized whenever necessary to furnish the proper flow to K-413. Three Beach-Russ pumps, located in the K-413 cold trap room, were used to compress the gas from line pressure to slightly above atmospheric pressure. The outlet gas of the cold trap was valved into a carbon trap which discharged into the atmosphere. A line recorder was utilized to analyze the incoming gases to the cold trap and chemical analyses were made to determine the percent of UF_6 in the cold trap outlet gas. A calibrated orifice, located in the inlet line to the cold trap, was used to meter the gas flows. The UF_6 hold-up was determined from the pressure decrease in the K-631 surge drums and from the cold trap gas inlet and outlet UF_6 concentrations.

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TEST RESULTS

The first run lasted for 5 3/4 hours before a pressure drop of 1 psi was obtained across the cold trap. The first $3\frac{1}{2}$ hours of the run were made with an average feed rate of 5.6 pounds of UF_6 per minute (336 pounds of UF_6 per hour). The last $2\frac{1}{4}$ hours of the run were made with an average feed rate of 3.5 pounds of UF_6 per minute (211 pounds of UF_6 per hour). The inlet gas concentration averaged 70% UF_6 throughout the run and the outlet gas concentration averaged .03% UF_6. The low flow experienced toward the end of the run was caused by low pressure in the K-631 drums. From the pressure drop in the surge drums and lines, a UF_6 hold up of approximately 1735 pounds was obtained in the cold trap.

The second run was made as a check for run No. 1. The run lasted for 5 hours before a pressure drop of 1 psi was obtained across the cold trap. The average feed rate to the cold trap was 6.0 pounds of UF_6 per minute (360 pounds of UF_6 per hour). The average UF_6 inlet concentration was 70% and the average outlet UF_6 concentration was .03%. From the pressure drop in the surge drum and lines, a UF_6 hold up of approximately 1790 pounds was obtained in the cold trap.

The third run lasted for 5 3/4 hours before a pressure drop of 1 psi was obtained across the cold trap. The average feed rate to the cold trap was 5.7 pounds of UF_6 per minute (342 pounds of UF_6 per hour). The average inlet concentration of UF_6 was 40% and the average outlet concentration was .1% UF_6. From the pressure drop in the surge drums and lines, a hold up of approximately 2100 pounds of UF_6 was obtained in the cold trap.

Run No.	Date	Length of Run (Hrs.)	Average Lbs. UF_6/Minute	Avg. Inlet Line Temp. (^oF.)	Average UF_6 Concentration Inlet	Average UF_6 Concentration Outlet	Lbs. UF_6 Hold-up
1	12-29-50	3.5	5.6	167	68%	0.03%	1735
		2.25	3.53	160	71.5	0.03	
2	1-3-51	5.0	6.0	166	70	0.03	1790
3	1-5-51	5.75	5.7	165	40	0.1	2100

The tests indicate that the 'size 1' cold trap will hold the 1200 lbs. of UF_6 that is necessary for the Phase II operation of the UF_6 Feed Plant if there is no additional plugging due to HF, dust, etc. Either a 70% or a 40% UF_6 inlet gas concentration may be fed to the trap at a rate of 333 lbs. of UF_6 per hour.

The UF_6 holding capacities obtained for the tests which have been completed have been calculated to be correct to $\pm$ 200 lbs.